An Apparatus and Method for Sonic Welding and Materials Forming

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Claims

What is claimed is:

1. An apparatus for sonic welding and materials forming comprising:

(a) a mechanical impulse source sonically coupled to single or multiple sonic waveguide(s), delay line(s), resonator(s), impedance transformer(s), and lens(es) which superpose high-power density sonic compression wave and shear wave impulses within the body of a workpiece;

(b) said mechanical impulse source generates high-power, single or multiple sonic compression wave impulses;

(c) said sonic lenses possess shape and composition attributes to focus sonic compression waves within the body of said workpiece;

(d) further, said sonic lenses possess shape and composition attributes to focus and mode convert sonic compression wave impulses into sonic shear wave impulses within the body of said workpiece; and

(d) said sonic wavegides, delay lines, resonators, and impedance transformers; which may be intrinsic to, or separate from the said workpiece, possess shape and composition attributes to direct and transmit sonic energy such that said sonic lenses superpose compression and shear impulses within the body of said workpiece.

2. The method of sonic welding of metallic materials with the apparatus defined in claim 1 wherein;

(a) sonic shear wave impulses, focused at the faying surfaces of a metallic workpiece consisting of two or more contiguous elements, transform all or part of said workpiece contiguous (faying surface) material from solid-to-viscoelastic state; and

(b) said sonic compression wave impulses, superposed on said shear induced viscoelastic material, fuse said contiguous metallic workpiece elements.

3. The method of metals forming with the apparatus defined in claim 1 wherein:

(a) said sonic shear wave impulses, focused within the body of a metallic workpiece, locally transform all or part of said metallic workpiece from solid-to-viscoelastic state; and

(b) said sonic compression wave impulses, superposed on said shear induced viscoelastic metal, dynamically forge said metallic workpiece into a desired shape.

4. The method of metallic materials substructure modification with the apparatus defined in claim 1 wherein:

(a) said sonic shear wave impulses, focused within the body of a metallic workpiece, locally transform all or part of said metallic workpiece from a solid-to-viscoelastic state; and

(b) said sonic compression wave impulses, superposed on said shear induced viscoelastic metal, modify metal substructure morphology;

(c) said substructure morphology modification in metals and their alloys be applied to relieve residual stress; and

(d) said substructure morphology modification in metals and their alloys be applied to

selectively alter mechanical and physical properties.

5. The method of sonic welding of non-metallic materials with the apparatus defined in claim 1 wherein;

(a) sonic shear wave impulses, focused at the faying surfaces of said workpiece consisting of two or more contiguous elements, transform all or part of said workpiece contiguous (faying surface) material from solid-to-viscoelastic state; and

(b) said sonic compression wave impulses, superposed on said shear induced viscoelastic material, cohesively bond said contiguous workpiece elements.

6. The method of non-metallic materials forming with the apparatus defined in claim 1 wherein:

(a) said sonic shear wave impulses, focused within the body of said workpiece, locally transform all or part of said workpiece material from solid-to-viscoelastic state; and

(b) said sonic compression wave impulses, superposed on said shear induced viscoelastic material, displace said workpiece into a desired shape.

7. The method of both metallic and non-metallic materials adhesive activation with the apparatus defined in claim 1 wherein:

(a) said sonic shear wave impulses, focused on an adhesive agent between two or more metallic and non-metallic workpiece elements to locally introduce energy of adhesive activation; and

(b) said sonic compression wave impulses, superposed on said activated adhesive agent, adhesively bond elements of said workpiece.

8. The method of non-metallic materials substructure modification with the apparatus defined in claim 1 wherein:

(a) said sonic shear wave impulses, focused within all or part of the body of said non-metallic workpiece, locally transform said non-metallic workpiece from a solid-to-viscoelastic state;

(b) said sonic compression wave impulses, superposed on said shear induced viscoelastic material, modify non-metallic material substructure morphology; and

(c) said substructure morphology modification be applied to selectively alter mechanical and physical properties of said non-metallic workpiece.